GENERAL SCIENCE QUARTERLY

A Journal of Science Education

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Science in French Elementary Schools

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Any adequate analysis of science courses in the elementary school curriculum of France must have as a background a thorough understanding of French educational theories and practices. As the French government is the best example of centralization of government found in any democracy, so is the French school system probably the best example in the world of centralization in education. The French have a theory that administration of government by experts is the best means of obtaining national solidarity to meet attacks from within and from without, so they reason that the same thing applies in eduation. The most effective means of education (they believe) will be to have an educational system as highly centralized as possible, the administration of which should be in the hands of educational experts. In practice this is what they have, although there is a slight tendency at present toward regionalism and decentralization. As a result the French courses of study are national courses of study and are never made out locally by cities or districts. Thus the teachers have no say as to what shall constitute the course of study, or what materials or textbooks may be used in accomplishing the aims of the course of study. There is in practice a worship of reason and an exaggerated emphasis on logic. Clear thinking and expression is the ideal goal to be obtained. This appeal to logic or reason permeates the whole school atmosphere. The purpose of French education is "to give a command of those things of which we cannot be permitted to be ignorant."

Naturally the purposes and aims emphasized above have developed a course of study in elementary science peculiar to a highly centralized educational system. Instruction in sciences

(as well as in other subjects) is by exposition rather than by text-books. Thoroughness is emphasized much more than in American science courses, and the note-book occupies a place of preeminence. The note-book is very elaborate, and well decorated with artistic drawings and serves as a text-book to the pupil. Text-books are used only as supplementary material and in content closely follow the course of study. In great contrast to the variety one would find in elementary science courses in the different schools of England or the United States, there is great uniformity in both quality and content of French elementary science courses for a given grade. The only variation in French elementary science courses is found in the Middle and Upper courses (age 9-13), where some provision is made for variation and differentiation in city and rural schools, or boys and girls—an attempt to take "into account the needs of the pupils, their environment, sex, and future occupations." This provision for variation is not found in the Preparatory course or Elementary course, so as a result city and rural children (ages 6-9) presumably receive the same instruction in science.

An attempt is made not only to make the sciences "train the mind," but to make them "practical" as well. The term "Object-Lessons" is applied to science study in the lower courses (to age 11) but in the Upper course the term used is "Physical and Natural Sciences." About fifteen minutes per day is allowed science in the Preparatory Course and Elementary Course and slightly more time in the Middle and Upper Courses—approximately twenty-five or thirty minutes in these two courses.

The keynote of method is experimentation and observation and the teacher is warned not to give lectures, but to get pupils to observe and experiment. The teacher is also advised against being too abstract or bookish in science instruction and that abstract terms such as gravity, magnetism, electricity and atmospheric pressure need to be abolished The simple and concrete should be emphasized and the teacher should always remember that "instruction will be everywhere experimental" and remain "practical" in all cases.

Downing in "Teaching Science in the Schools" says: "This material is presented in talks by the teacher or in a series of small books used as readers. Since it is in the course of study

which is prescribed uniformly for all schools by the central authority, the science work is given, but as a rule it is perfunctory and formal. The children are supposed to get the necessary background of experience for themselves. There are, of course, occasional teachers who are sufficiently enthusiastic to bring nature material into the school for actual study at first hand, or even take pupils out of doors for such study outside of school hours, but they are the exceptions."

The French ideal of "ability to handle ideas and think things though" (referred to above) does not seem to be logically followed out in their science courses, judging from an inspection of the distrubtion of science materials through the grades. The course seems to be made up of a series of observations with no connecting links or generalizations. The course seems (in the lower grades) to be observations about things of much the same character that has made Nature Study more or less purposeless in American schools. The more advanced work of the Upper course seems to be sections of materials from the fields of Biology, Chemistry, Physics, Geology, etc., organized neither as subject matter or topically. The serial theory of child development and the concentric circle idea of education are almost ideally typified in the French science courses.

There seems to be implied in the organization some magic properties of the month that makes each month suitable for a certain topic. Thus soil and rock formation are studied in October of the first year of the Upper Course and again in October of the second year. Similarly "weight" is a December subject both years, and January is designated as the month for studying electricity. In order to make the teacher realize that she is to teach through observation, rather than mere learning about things vicariously, the lesson is indicated by the object to be studied rather than by the topic.

The concentric circle idea is illustrated by the following examples taken from the official course of study:

ELEMENTARY COURSE

FIRST YEAR

October

1. Digestion, mouth and teeth. Stomach and intestines. How one should eat.
2. Breathing. Nose and mouth, the lungs. How one should breathe.
3. Movements. Bone and muscles. Good and bad position.

4. Hygiene. Eyes, ears, nails and hair.

December

1. It is cold. Winter clothes and summer clothes. Hoar frost.
2. Combustibles. Charcoal. A piece of coal. Kerosene.
3. Heating. A fireplace. A match. Fire and smoke.
4. Illumination. A wax candle and a tallow candle. The flame. A wick, a spirit lamp.

May

1. A bee. A beehive. Honey and cake of wax.
2. Vegetation, a year-old chestnut tree. A stalk of wallflower.
3. Flax and hemp. Tow, cloth and rope.
4. An oak. The woodcutter. His ax and saw.

SECOND YEAR

October

1. Story of a mouthful of bread. Let us chew, let us swallow. The course of the food in the digestive tract. Advice on hygiene.
2. The chest. Respiratory movements. The heart beats, the blood circulates (pricks, cuts).
3. Physical exercises. The muscles in action when walking. Contraction of the arms.
4. Advice on hygiene. The skin, cleanliness of body, of linen, of clothes.

December

1. It freezes. Ice. Snow.
2. Fuel wood. Coke. Alcohol for fuel.
3. A stove. Let us prepare and light a fire. The bellows.
4. A kerosene lamp. An alcohol lamp. Gas for lighting and a gas burner.

May

1. A wasp. A fly. Let us destroy the flies (slides or engravings).
2. Let us get some beans to sprout. A stalk of the lily of the valley. A pine.
3. The cotton plant, cotton (slides or engravings). Thread and texture of cotton.
4. An apple or walnut tree. The carpenter. A table.

MIDDLE COURSE

FIRST YEAR

November

1. Air. Properties. A bicycle pump and the air chamber, an air piston; elasticity, compressibility. Warm and cold air: in the classroom. The wind: regular winds at seashore.
2. Composition of the air. Mixture of two gases: observe candle or phosphorus burning in the air of a bottle turned upside down on the water. Oxygen and nitrogen: properties. Dust and carbon dioxide gas contained in the air. (Experiment: lime water.)
3. Combustion. Oxygen necessary to combustion; we light the fire. The bellows. The flame: of the wax candle, of the oil lamp (glass); of the gas burner (yellow or blue).
4. Heating and lighting. Carbon. Wood, coal, peat: combustion. Oil, fat, kerosene, alcohol: combustion.

SECOND YEAR

November

1. Air has weight. Pressure of air; air-holes, small pipe, droppers. The barometer: use, description.

2. Oxygen: preparation (potassium chlorate or oxylithe). Properties (Experiments). Slow and rapid combustion. (Rusting and breathing.)
3. Combustion. Products of combustion of coal and wood: carbon dioxide, steam and ashes. Carbon dioxide: preparation. Properties (Experiments). Dangers.
4. Coal. Coal mining. Extraction. Distillation of wood: charcoal. Distillation of coal: illuminating gas and coke.

UPPER COURSE

FIRST YEAR

April

1. Alcoholism. Alcoholic drinks. Fermented drinks: wine, cider, beer. Distilled drinks: brandy, liquors.
2. Alcoholism. Action of alcoholism on the organism. Consequences. Contagious diseases. Microbes: examples (pictures or slides).
3. Contagious diseases. Typhoid fever, tuberculosis, eruptive fevers. Precautions to be taken.
   Vaccination and revaccination.
4. Animals. Classification. Five branches: vertebrates (cat); articulates (may-bug); worms (earthworm); mollusks (snails); radiates (starfish).
   Vertebrates: mammifiers (dog), birds (chicken), reptiles (lizard), batrachians (frog), fish (herring).

SECOND YEAR

April

1. Alcoholism. Alcoholic fermentation in wine making. Distillation of alcohol. An alembic.
2. Alcoholism. Action of alcohol on the nervous system, the heart, the arteries, the stomach, the liver, the kidneys.
   Contagious diseases. Study of anthrax, hydrophobia.
   Aseptics and antiseptics.
3. Contagious diseases. Diptheria and cholera.
   Protection against disease.
4. Animals. Classification as in first year.

Thus one finds that the corresponding month of the second year of the same course repeats the materials covered in the first year, there being some slight variation in the content presented. Not only is there repetition in the same course, but among the courses. Materials found in the Middle or Upper Course are also found in the Elementary Course. Repetition of materials seems to be an outstanding characteristic of French elementary science courses.

The important thing in science teaching as American teachers see it today, is relationships, but it is rather difficult to see anything of relationships in the course of study in science in the French schools. However, it may be brought out through the methods of teaching, and so taken for granted as to be assumed in the outline of courses. It would seem as though the French have made the same mistake that was made in this country of putting in a lot of facts about plants and animals

and calling it "Nature Study." The French have gone further than we in putting organized science into the lower grades in the sense that a definite program has been made. However, the organization does not seem to extend to the material itself. The nature study program in this country is open to the same criticism, however. It has been in the past, and still is where teachers have not been trained in the more recent practices, a great deal of observation and description about plants and animals merely for the sake of recognition. Recognition (and by this I mean ability to name trees, flowers, animals, birds, rocks, and etc.) plays an important part in the science education of young children and is an important means of maintaining interest, but it is not an end in itself. The recognition should be a part of a still more comprehensive plan. However, it seems more surprising that the French should not have an organized plan because of their characteristic respect for reasoning. Many of the aims of their science teaching are in agreement with the best thought in this country, but it is difficult to see how these aims are accomplished through the use of subject matter as outlined by their assignments. It is possible that this is accomplished through the methods and personality of the teacher and would be noticed if the schools themselves were visited, but there is no indication of this in the subject matter organization or methods as presented in their text-books and instruction book for teachers.

A brief resume of the science studied in the various stages of the elementary school (taken from "Official Programs and Instruction")

Preparatory Section

Age 6-7

Object Lessons (in class and on walks). Familiar exercises and conversations, intended to make children acquire the first common information (right, left; days, months, seasons; north, south, east, west; animals, vegetables, minerals, air, water) and leading them to observe, compare, and ask questions.

Very simple notions of the human body.

Hygiene (very simple lessons).

ELEMENTARY COURSE

Age 7-9

Object Lessons (in class and on walks).

Observations accompanied by simple explanations; Common objects and phenomena, animals, vegetables and minerals brought to class or found during the walk with pupils; principal manufactured materials in common use; foods, fabric, paper, wood stone, metals.

Hygiene: practical exercises (cleanliness of body, of clothes, and of classroom).

First lessons in agriculture and horticulture in the school garden.

MIDDLE COURSE

Age 9-11

Object Lessons (in class and on walks).

1. The three states of bodies. Notions on air, water and combustion; notions on hydrogen, oxygen (simple bodies) and on carbonic gas (compound bodies). Simple experimental demonstrations.
   Practical properties of some of the common metals.
2. Man. Elementary description of the human body and ideas on the principal functions of life.
   Animals. Idea of classification into some groups; idea of distribution of vertebrae into some classes, with the aid of an animal representing each type.
   Useful and harmful animals of the region.
   Vegetables. Idea of the principal functions of plants.
   Notions on the great divisions of the vegetable kingdom, using a plant as a type to illustrate in each case.
   Useful and pernicious plants of the region.
3. Housekeeping instruction (for girls).
4. Hygiene (Practical exercises) Keeping body, clothes and classroom clean.

UPPER COURSE

Age 11-13

Common Elements of Physical and Natural Sciences (Observations and Experiments. Class exercises and walks).

Physical sciences. Simple experiments and elementary no-

tions, having as main purpose the study of scale, barometer, thermometer, compass.

Elementary notion on most common application of electric current.

Elementary notions on metals and common salts.

Natural sciences. Further study of man, animals, vegetables.

Elementary notions about soils, rocks, fossils, conformations of earth; example drawn from the locality.

Hygiene. Practical Exercises. Elementary notions on the causes of diseases (microbes, parasites) and on hygiene of breathing, of nutrition (dangers of alcoholism) on clothing and the home.

Housekeeping instruction for girls. Practical exercises on cooking and cleaning. Elementary notions on the principles and practices of scientific housekeeping. Care of infants. agriculture and horticulture. More systematic notions on cultivation (of fields, gardens, woods), on natural and artificial fertilizers, on soil and its improvement, on domestic animals.

The above topics are arranged in a definite month and given in more detail in the "Official Distribution of Subjects."

A College Course in General Science

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The teaching of General Science in the High School is a recent development and the subject has hardly yet been accorded a place on a level with other sciences.

But a still more recent development is the teaching of General Science in colleges and universities. This is done under various titles, as Orientation Course, Survey Course, General Science, or some similar name.

Many of the same arguments which are used in favor of High School General Science may be used for a college course.

First: General cultural knowledge for those not scientists nor, primarily interested in science. It gives the underlying facts about the world in which we live and man's relation to his environment to those who want a knowledge of scientific thought and discoveries. Second: For specialists in some one branch of science. It answers the want of those who feel the need of a broad view of the whole as well as a specialized knowledge of one field. Third: Many would like a survey of the whole field of science before picking out their special field.

At the State Teachers College, as an experiment, a course in General Science was offered to College Juniors and Seniors. This was an elective course under the Department of Biology. There was a prerequisite of one year each of Biology and Chemistry. The class met twice a week for lecture and once a week for a two hour laboratory period for the whole year.

This course endeavored to have some of the features both of on orientation course and of a method course for future teachers in General Science.

"The Nature of the World and of Man" was used as a text book, and there was assigned reading on topics discussed in class. The students were encouraged to do as wide and as varied reading as possible. Some lectures were given by specialists in certain fields, but the class was for the most part under the leadership of one instructor. Such topics were stressed as seemed to fit the peculiar needs of the class or were of special interest to them.

In the spring quarter, time and opportunity was given to each member of the class to select some topic in science and do special reading and a little original research along some line in which she was especially interested. For instance, one girl did considerable reading on Burbank and his work. Another one worked up a very good paper on Virginia Scientists and Inventors.

The two hour laboratory period was taken up almost entirely with the methods course. All the members of the class were prospective teachers and with few exceptions were majoring either in Biology or Chemistry. They expected to be called upon to teach General Science in the High Schools when they left college. Therefore, it was the endeavor to make this part of the course as thorough and as practical as possible.

The class did some laboratory work of a college science grade when it seemed necessary to illustrate some principle studied in the lecture periods. But for the most part the experiments were given, worked out and written up as a High School class would be expected to do them. So that each girl had a model notebook of experiments for a High School general science class.

The aims and objectives for a High School general science course were thoroughly worked out, as well as the other phases of the theory of the teaching of General Science.

A course of study was outlined. Most of this course of study has been tested by experienced teachers, and it was used almost in its entirety in the General Science class of the College Training School.

Practical problems and difficulties were discussed and suggestions made as to ways and means of meeting them.

In short, it was the endeavor to give a course to prospective teachers which would send them out prepared both in subject matter and in theory to teach General Science to the High Schools.

Some of the results obtained were an understanding of the importance of General Science and a greater enthusiasm for teaching science.

A Study of General Science Textbooks

Ailsie M. Heineman

Today, the field of General Science textbooks constitutes a land of plenty. Not only is the supply plentiful, but varied as well. Authors of General Science textbooks declare in their prefaces their intention to produce books differing from those of their predecessors. No doubt the intention in every case is similar. A better book, in the sense of a book better meeting the needs of a beginner in science, is the ambition of each writer. What constitutes a good book in General Science, however? What sort of book would be satisfying to the majority of General Science teachers? Or, to state the case negatively, what is the lack experienced? With these considerations in mind, the writer made a study[1] of twenty General Science textbooks, in order to discover how much importance was accorded principles, since principles are the foundation of a science. Such an approach the writer recognized to be one of several possible approaches, but one compatible with our conception of a science.

A principle, in the terms of this study, was taken to mean a statement of relationship between two or more facts; usually causal in nature. A principle can be better understood, perhaps. by distinguishing it from a generalized fact, for which it is often mistaken. "Solids expand with heat and contract with cold" is an example of a generalized fact. Similar statements could be made with regard to gases and most liquids, in turn substituting the words "gases" and "most liquids" for "solids" in the previous statement. A principle, in contrast to three such generalized statements, brings out the relationship existing among the three. Expressed in terms of a principle, these three distinct statements might become this: "Solids expand with heat and contract with cold, as do most liquids and gases."

The advantage of such a principle over a generalized fact

1 "A Determination of Principles and Problematic Situations Found in Twenty General Science Textbooks," a Dissertation offered for the Degree of Master of Arts, the University of Chicago, September, 1927.

seems apparent. There is less tax on the memory, yet, paradoxically enough, the memory retains more. Just as the bits of colored glass in a kaleidoscope do not remain separate bits but become part of the pattern disclosed, so, in the case of a principle, a number of facts yield to a scientific pattern. The pattern is easier than the separate elements to appropriate, and is more inclusive.

Even though such a principle be afforded, however, its mere statement does not constitute its value. It must be applied to life situations before its full significance is realized. Judd[2] emphasises the necessity of teaching both principle and its application, in view of the fact that the latter is a difficult mental feat, and not, as is commonly supposed, one identical in character with the process of generalization. Downing[3] says of the necessity of applying principles:

> "Not only, however, must the principle be learned, but drill must be given in carrying it over into life-problems. . . . A student in Biology may learn Mendel's laws but unless the teacher takes pains to show how these laws apply to the human situation, not in single instances but repeatedly, the law remains a bit of interesting school science but has no effect on life's problematic situations."

Examples of such applications to principles are common to General Science textbooks. A few of the hundreds found in the course of this study might be listed here by way of illustration. Using the principle previously stated, that of expansion and contraction, the following applications (taken at random from textbooks studied) are indicative of what is meant by applications to life-situations:

Why do waves rise over a road on a hot day?
Why do hot liquids break ordinary glass?
Account for spaces left between ends of iron rails on a track?
Why does a bicycle tire get harder by standing in the sun?
Why is hot water drawn off the top of a heater?
How can glass stoppers be safely removed from bottles in which they fit snugly?
Why do water pipes burst in freezing weather?

The above represent situations with which all young people come in contact, and are therefore distinctly life-situations.

Twenty textbooks in General Science were selected for this

2 Judd, "Psychology of High School Subjects," p. 424.

3 Downing, "Teaching Science in the School," p. 102.

determination of principles and their application to life-situations. No book published before 1915 was used, and the latest book included was of the year 1925. Selection of books was made largely on the basis of the author's preface. Whenever a book made claim to being the result of years of teaching in the field, or was recommended for the beginning year of science, it was included. Those books which were called "Guides" or "Manuals" or which claimed to be radical departures from the usual treatment of General Science textbooks, were not included. The list of books, selected and arranged according to the date of publication, includes the following:

1915—Clark, Bertha M. *An Introduction to Science.*
1916—Barber, Frederic Delos. *First Course in Science.*
1916—Elhuff, Lewis. *General Science.*
1916—Weckel, Ada, and Thalman, Joseph L. *A Year in Science.*
1917—Clute, William Nelson. *Experimental General Science.*
1917—Coulter, John G. *Elementary Science.*
1918—Brownell, Herbert. *A Textbook in General Science.*
1918—Caldwell, Otis, and Eikenberry, William Lewis. *Elements of General Science.*
1918—Pease, Clara A. *A First Year Course in General Science.*
1919—Hessler, John C. *The First Year of Science.*
1919—Snyder, William H. *Everyday Science with Projects.*
1920—Smith, Wayne P., and Jewett, Edmund Gale. *An Introduction to the Study of Science.*
1920—Trafton, Gilbert H. *Science of Home and Community.*
1921—Bedford, Edgar A. *General Science, A Book of Projects.*
1922—Hunter, George W., and Whitman, Walter G. *Civic Science in the Community.*[4]
1922—Tower, Samuel F., and Lunt, Joseph R. *The Science of Common Things.*
1923—Bowden, Garfield A. *General Science with Experimental Project Studies.*
1924—Webb, Hanor A., and Didcoct, John J. *Early Steps in Science.*
1925—Pieper, Charles John, and Beauchamp, Wilber Lee. *Everyday Problems in Science.*
1925—Van Buskirk, Edward F., and Smith, Edith Lillian. *The Science of Every Day Life.* (Rev.)

The prefaces of these twenty books disclosed the fact that most authors had more than one aim in writing their books, and that no one gave first place to the study of principles, the matter of concern in this determination. Eleven aims were

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4 [It should be noted that this text is one of a two-book series and intended to cover only a limited part of the science work in the Junior High School. Its use in comparison with texts written for the first year of high school is, therefore, likely to give results which are a bit misleading.—Ed.]

found. Those having a frequency of two or more are listed here in the order of decreasing frequency:

11 authors, "Study of Environment." (7 gave first place.)
10 authors, "Scientific Attitude." (2 gave first place.)
8 authors, "Interest and Appreciation." (4 gave first place.)
6 authors, "Knowledge." (2 gave first place.)
5 authors, "Introduction to Science." (1 gave first place.)
3 authors, "Good Citizenship." (2 gave first place.)
2 authors, "Understanding of Principles." (None gave first place.)

The aim showing the greatest agreement among writers was "Study of the Environment," which was mentioned eleven times and given the first choice in seven instances. This aim indicated that over half the authors planned to draw upon material familiar to the pupil. No one of the twenty authors gave first place to the study of principles, although two mentioned it. The scientific attitude of mind was an aim with a frequency of ten, however, and may be indicative. Since the scientific attitude implies the inquiring attitude, and since the inquiry is probably intended to bring out the scientific explanation of the phenomenon, it is possible that these ten authors had principles in mind in proposing the scientific attitude of mind. Regarding the two aims—understanding of principles and the scientific attitude—as one, it would seem that over half the writers of the textbooks studied were concerned with the scientific side of General Science. A promise of principles, however, was not forthcoming.

As this study was to be both qualitative and quantitative, principles and their application to life-situations were listed as found and their share of the total printed material (in square inches) calculated. Before such a quantitative determination could be made, it was necessary to discover the general organization of these books. Such a study was made the initial step.

The general organization of the twenty books was studied from two angles. First, there was a determination on the basis of words, lines and pages. These in turn were converted into square inches. From this study were derived these results: the space (in square inches) given to blank spaces, illustrations and printed matter. The area of printed matter was indispensable for later work, as space given to principles and their application constituted a fraction of this total. Results

of this study showed wide variation in books. The number of chapters ranged from 10 to 50; pages from 284 to 658; illustrations from 96 to 524. On a square inch basis these differences were less marked. Bowden headed the list in the matter or area of printed matter after all deductions, with 13.007 square inches, while Coulter had the fewest number of square inches, 4,830. The following averages were obtained from this study of the organization of books:

Number of chapters, 26.5 (range 10 to 50).
Pages per chapter, 23.44 (range 7.17 to 62.6).
Total number of pages, 467.4 (range 284.0 to 658.0).
Total number of illustrations, 262.35 (range 96 to 528).
Area of printed matter (page), 21.99 (range 19.69 to 25.0).
Words per page, 344.76 (range 259.5 to 399.7).
Words per line, 9.99 (range 8.95 to 10.8).
Words per square inch, 16.36 (range 13,18 to 16.6).
Lines per page, 34.27 (range 29 to 38).
Total available area (in sq. inches), 10,300.94 (range 5,956.33 to 15,575.00).
Area of illustrations, 1,870.02 (range 641.13 to 3,670.87).
Area of blank spaces, 360.63 (range 135.13 to 790.00).
Area of printed matter after all deductions, 7,988.06 (range 4,830.33 to 13,007.00).
Number of words of total printed matter, 127,367.28 (range 76,395 to 207,106).

The range represented by these twenty books is strikingly large and would seem to indicate that no standardization in general organization has been attained.

The other angle from which general organization was studied was that of subject matter, based on the table of contents of each textbook. The purpose of this study was to find what sciences were represented. As this was not the major feature of the determination, the work was confined to the table of contents. No recognition was taken of possible deviations in the text from the material suggested by the chapter titles.

Eight sciences were represented, and for convenience (since they were slight in amount) three sciences were grouped as one. The following list shows both the sciences found and the order of rank, on the basis of space given:

1. Physics.
2. Biology.
3. Geography, Astronomy and Meteorology.
4. Physiology.
5. Geology.
6. Chemistry.

It is evident that Physiology would have third place, were the three sciences not grouped. Expressed differently, Physics,

Biology and Physiology are considered indispensable to a General Science course by these writers. There was but one exception in each case. Geography, Astronomy and Meteorology, either all three or one of the three, were found in all the books except one. Geology was treated in eleven, while Chemistry was treated in just nine books. A miscellaneous grouping was resorted to, to care for material that could not be classified as scientific. In one case this miscellaneous subject matter amounted to 53 per cent, indicating a tendency to include material of interest, perhaps of personal interest, but equally available in good reference material. These results seemed to substantiate the statement that General Science constitutes a group of special sciences. However, there was shown little tendency to devote space to one science to the exclusion of all others.

A rough classification of illustrations was made, to see to what extent scientific illustrations were used. This was corrected and the following kinds of illustrations found to be representative: apparatus, charts, demonstrations, diagrams, foods, instruments, maps, photographs, scenery, strictly scientific and unclassified. Of these eleven groups, three seemed to be of doubtful scientific value, namely photographs, scenery and unclassified. In general, however, a tendency to use liberally scientific material was observed. No writer used less than 66 per cent scientific illustrations, and one (Clute) used nothing but scientific illustrations. Objective means of evaluating these illustrations were lacking, so it was difficult to weigh such considerations as clearness and aptness of illustrations. An old copy of a book was likely to prejudice the judgment. Diagrams involving the use of fine lines seemed to become indistinct sooner than did photographs. One habit, however, and one irrespective of the age of the book, seemed to militate against a good impression of the book. This was a tendency to fence in illustrations with words. In books in which this tendency was marked, illustrations seemed to lose in effectiveness.

Principles or generalizations were the next feature of this study. The sciences likely to be found represented had been discovered in the study made of tables of contents. Hence classification was facilitated. Ninety-three principles were found; by far the greatest number having to do with Physics.

Within the subject of Physics—Gases, Liquids, Heat and Mechanics received the bulk of attention given to principles. In Biology, there was less agreement as to which principles were needed in a General Science course, although seventeen were given. In Chemistry, although only four principles were found, these principles were advanced by a number of authors. for example, number 19, "Oxygen is necessary for combustion and life," was used by eighteen of the twenty authors. Every book was examined at least twice for principles, and in addition the index was used as a check. For example, "Capillarity" (which suggests a principle), if found in the index, was traced to see if the principle was expressed. In all cases an expression of principle was deemed necessary, if it was to be included. While not all such generalizations were expressed in admirable form, they were credited if given. No principle that had to be inferred was counted. The following table (Table I) gives the number of generalizations used by each author of a General Science textbook, the square inches devoted to these generalizations, and the per cent total printed matter represented.

Several findings of interest were the result of this study. Clute used a greater number of principles (45) than any other writer, and Trafton had the fewest principles (7). In other words, Clute used close to 50 per cent of the total number found, and several authors used approximately 30 per cent of the total number. On the square inch basis, the order of books would need revision to show the ranking of books. The following order is that in which the books fall if arranged with respect to per cent of space given to principles:

1.	Clute	1917	12.11%
2.	Caldwell and Eikenberry	1918	12.08%
3.	Elhuff	1916	8.58%
4.	Bowden	1923	8.20%
5.	Coulter	1917	8.10%
6.	Snyder	1919	7.87%
7.	Brownell	1918	7.26%
8.	Weckel and Thalman	1916	6.85%
9.	Barber	1916	6.55%
10.	Pease	1918	6.18%
11.	Pieper and Beauchamp	1925	6.16%

TABLE I.

Summary of Results of Study of General Science Textbooks.

	Author	Year	No. of General-izations	Sq. In. of General-izations	Per cent of General-izations	No. of Principles Applied	Sq. In. of Appli-cations	Per cent of Appli-cations	Total No. of Illus-trations	Sq. Inches of Illus-trations	
1.	Barber	1916	27	691.95	6.55	9	217.63	2.04	375	3,075.50	1.
2.	Bedford	1921	18	268.88	4.91	29	264.44	4.82	296	2,234.125	2.
3.	Bowden	1923	31	1,066.25	8.20	21	536.0	4.12	334	2,084.87	3.
4.	Brownell	1918	34	514.17	7.26	17	71.63	1.18	118	1,298.50	4.
5.	Caldwell and Eikenberry	1918	32	810.23	12.08	27	634.77	9.47	181	1,873.75	5.
6.	Clark	1915	27	421.34	5.41	20	482.15	6.20	346	1,963.25	6.
7.	Clute	1917	45	633.94	12.11	36	592.13	11.31	96	641.125	7.
8.	Coulter	1917	26	391.15	8.10	24	275.59	5.71	107	646.75	8.
9.	Elhuff	1916	30	630.22	8.58	23	272.63	3.71	256	1,174.16	9.
10.	Hessler	1919	27	402.85	4.98	34	442.08	5.46	346	1,278.188	10.
11.	Hunter and Whitman	1922	10	106.00	1.63	7	44.52	0.69	285	2,011.625	11.
12.	Pease	1918	31	304.22	6.18	21	129.32	2.63	170	1,494.50	12.
13.	Pieper and Beauchamp	1925	31	556.84	6.16	30	308.07	3.41	508	2,720.94	13.
14.	Smith and Jewett	1920	24	614.51	5.00	28	280.41	2.21	173	1,112.125	14.
15.	Snyder	1919	41	696.91	7.87	18	260.72	2.71	524	3,670.875	15.
16.	Tower and Lunt	1922	21	327.78	5.63	15	286.73	4.93	184	1,660.281	16.
17.	Trafton	1920	7	103.24	1.10	9	227.48	2.43	218	1,859.00	17.
18.	Van Buskirk and Smith	1925	32	516.95	5.24	24	279.75	2.81	240	1,852.75	18.
19.	Webb and Didcoct	1924	36	627.00	5.98	21	257.83	2.45	298	3,352.50	19.
20.	Weckel and Thalman	1916	24	447.69	6.85	10	135.60	2.07	192	1,395.625	20.

12.	Webb and Didcoct	1924	5.98%
13.	Tower and Lunt	1922	5.63%
14.	Clark	1915	5.41%
15.	Van Buskirk and Smith	1926	5.24%
16.	Smith and Jewett	1920	5.00%
17.	Hessler	1919	4.98%
18.	Bedford	1921	4.91%
19.	Hunter and Whitman	1922	1.63%
20.	Trafton	1920	1.10%

The conclusion seems to be inevitable that no one of the books is built around principles to any extent, but that the books of Clute and Caldwell and Eikenberry devote the greatest amount of space to principles of any books studied. The dates of publication have been included in the list, as they bring out another point worthy of note. With the exception of Bowden's book, the older books (those written before 1920), make the better showing in the matter of principles. It is probable that more recent books have emphasied the practical needs of pupils, with a sacrifice of scientific principles. That the individual rather than the subject should be taught is an increasingly recognized principle, but there seems to be no reason to assume that these needs should be opposed to the principles governing a science.

It is an open question whether applications to principles should be grouped with such principles in a determination of space devoted to principles. The writer has kept the two separate, but recognizes the close relationship between principles and applications. Such an union would not invalidate the findings.

Over 2,000 applications to life-situations were found and were classified as Explained Problems, Inference Problems, and Exercises. *Explained Problems* were those that were discussed at length in connection with the principle. *Inference Problems* were unusually brief, in question form for the most part, and left for the pupil to solve. While these problems do not require much space from the standpoint of square inches, they constitute a body of concentrated scientific matter. Examples of inference problems were given earlier in this paper. *Exercises* include directions to perform some activity, such as making an iceless refrigerator. This group of applications was

not included in the percentages shown in Table I, as there was a question as to their problematic nature. Such an application as that of making an iceless refrigerator may or may not involve a problem, depending in large measure on the teacher. If the work becomes merely one of construction of apparatus, a project perhaps, it ceases to serve as a problematic situation. Hence such exercises were excluded from a percentage calculation but listed, as their value to the pupil can scarcely be questioned.

If the number of principles used and the number applied be compared (Table I), surprising results are to be observed. Barber, for instance, is found to use 27 principles, but to apply only nine. In general, certain principles seemed to remain unapplied. A very different sort of result is the case of Hessler, who used 27 principles but used applications to 34 principles. How to interpret this is a question. The author may have thought he expressed the principle. He may have deemed the full statement unnecessary, or he may have expected the pupil to evolve the principle for himself. As such applications were Inference Problems, in the main, it is quite possible that the pupil was expected to find the principle, even though he failed to articulate it properly.

Table II shows the relationship between principles and applications. The first column in each case gives the original number of the generalization (stated in full in dissertation); the second indicates the number of authors giving the principle, and the third the number of authors applying the principle.

The gaps are the most significant feature of this table. At the very outset, several principles (having to do with Biology) are not applied. Numbers 18 to 21 inclusive have to do with Chemistry, and three of these are applied. Numbers 31, 33, 35, 36 to 39, have to do with Meteorology. For the most part, the other principles which are applied are in the field of Physics. This table brings out even more clearly than Table I the fact noted above, that certain principles were involved in applications although unused as principles. Why Physics should be applied, almost to the exclusion of the other sciences, is a matter for conjecture. The environment of the pupil may be more fruitful in such applications; such applications may

TABLE II.

A Contrast to Show the Number of Principles (A), Authors Using Principles (B), and Applications (C).

A	B	C	A	B	C	A	B	C	A	B	C
1	5	..	25	8	..	49	1	..	73	6	..
2	3	..	26	2	..	50	10	3	74	4	1
3	3	..	27	2	16	51	1	..	75	6	2
4	2	..	28	6	7	52	2	..	76	11	..
5	1	..	29	5	3	53	3	1	77	9	4
6	5	..	30	9	6	54	1	3	78	7	..
7	7	..	31	5	5	55	13	18	79	12	11
8	4	..	32	3	3	56	7	18	80	7	11
9	5	..	33	1	..	57	9	8	81	11	11
10	3	..	34	1	4	58	1	1	82	3	1
11	4	..	35	18	18	59	9	8	83	9	10
12	8	..	36	8	1	60	1	..	84	8	..
13	2	..	37	7	..	61	17	17	85	11	11
14	3	..	38	7	2	62	1	..	86	2	..
15	3	..	39	7	..	63	10	11	87	12	13
16	2	..	40	14	10	64	2	19	88	12	12
17	3	..	41	13	10	65	1	..	89	10	3
18	8	11	42	1	..	66	7	2	90	8	12
19	18	18	43	9	..	67	2	8	91	1	..
20	4	..	44	5	9	68	9	4	92	3	2
21	1	7	45	1	12	69	10	3	93	5	..
22	4	..	46	5	14	70	4	2			
23	1	..	47	11	14	71	10	10			
24	6	..	48	1	1	72	12	13			

be more easily found, or there may have been less attempt to search the field for applications to such sciences as Biology.

Principle 64, "Ready absorbers of heat are ready radiators, while slow absorbers are slow radiators," was applied the greatest number of times, 210. Number 61, the principle dealing with expansion and contraction, was applied 139 times. From these high frequencies, applications tapered off to some ten principles which were applied just once. The most striking result was the preponderance of applications to the principles of Physics.

In conclusion, it should be observed that the writers of these twenty General Science textbooks did not express any intention of writing books on the basis assumed by this study, namely that of principles. However, principles were found in all books. Clute and Caldwell and Eikenberry devoted prac-

tically the same amount of space to principles (12.11 and 12.08 per cent respectively). The books of Hunter and Whitman and Trafton gave the least space to principles. No book in the group could be said to be organized in terms of principles, but the principles of Physics received the largest attention accorded any principles. The general organization of these books gave no evidence that there was an intimate connection between the size of a book and the number of principles and applications found. Clute's book, for instance, has next to the fewest number of pages (294) and is among those books having a large number of chapters (41), yet this book ranks first in point of principles and applications. It seems probable that in those books which had fewer chapters and more pages, that considerable padding was employed. The study of these books from the standpoint of sciences represented bore out this conviction. In the latter case, those books with large chapters were found to be crowded with miscellaneous material. This material may be of personal interest to the author, or may be merely encyclopedic in nature. While the tables of contents would indicate that eight sciences were represented by these books, Physics and Chemistry have the largest representation from the combined standpoints of this study—principles and their application.

Ninety-three principles and over two thousand applications to principles were found. No author gave all these principles, although one author gave approximately 50 per cent of them. Certain principles were not applied, though expressed, and certain ones were applied even though not expressed. In some cases, principles not to be found in any of the twenty books were applied. Had these authors intended to make a point of principles and their applications, these findings might be surprising, but in view of their aims, lack of a complete statement of a principle would not constitute a lack from their point of view.

Although General Science textbooks are numerous, the results of this study would indicate that a book built on principles is yet to be written. Such a book would be in accord with the definition of a science, and were it enriched with ap-

plications to life-situations it might meet a real need of the General Science teacher. The authors of the twenty books studied show which principles they regard as important to a course in General Science. These principles could be taken as the point of departure in framing the principles wise to include in such a course. The list of applications affords ample choice of applications to such principles. One group might be used to explain the principle at the point of presentation; another to use as a supplementary material at the end of a chapter, and still a third set of applications might be used near the end of the book to test the results accomplished by the course in General Science. In this case, the applications would be given in assorted form, so as to give practice in determining which principle was involved.

It would be difficult to estimate the value of a course of study that left clear-cut in the pupil's mind ten to twelve well-defined principles for each science represented. Each science could then build upon the results achieved by the previous science. Continuity, the absence of which is charged to be the serious lack in science, would be made possible.

Teaching the Electric Motor

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"What is it?" "What is it for?" "What can you do with it?" "Let's see it work." "Let me try it." These are pupil reactions that set the stage for real science teaching. Use, interest and activity are the keys which will unlock the doors of learning. Teachers of general science are everywhere taking account of this fact. However, in this scientific age, with its many applications of scientific principles, the science teacher is in danger of becoming bewildered in trying to give the pupil a passing acquaintance with the many applications which the textbook makers and curriculum experts seem to think the pupil should know. A little perusal of the subject matter general science classes are expected to cover reminds one of the boy who set a hen on one hundred eggs. When asked why he gave her so many eggs to cover, he replied, "I just wanted to see her bust herself trying to cover them."

All of which is not so much a criticism of the modern general science text as it is a plea for its intelligent use. The general science lesson is not complete until another type of question has been stimulated and answered: "What makes it go?" "How does it work" "Upon what principles does it depend?" It is agreed that interest, use and activity are fundamental in education, and especially in science, but certainly they should lead to insight and understanding. Familiarity with the use of a machine and a sense of its economic value are indispensable outcomes, but they are in themselves insufficient unless they are accompanied by an understanding of principles involved.

The following description of the study of an electric motor will have a degree of worth, it is hoped, because it is an effort to make the pupil really understand the fundamental principles involved in the motor or, in other words, "what makes it go" and because the apparatus used is so simple that no teacher need slight this interesting subject because of lack of apparatus. Three magnets, some wire, a small iron rod, a phonograph needle, some iron filings and two dry cells are all that is necessary. Two of the U magnets used in the Ford magneto will

serve in the place of two bar magnets if a small platform is made to support them with one of the poles below the platform. These magnets are usually strong and may be had for the asking at almost any garage. The apparatus here described has been used successfully in general science classes and also in method classes for teachers of general science. In one or two instances boys have built motors themselves after a study of this one.

We begin the unit with a study of magnets using the U magnets referred to before. One of these is suspended with a fine cord and the pole which turns to the north is marked. A second one is suspended and marked in the same way. Then by trial the pupils learns that like poles repel each other and unlike poles attract.

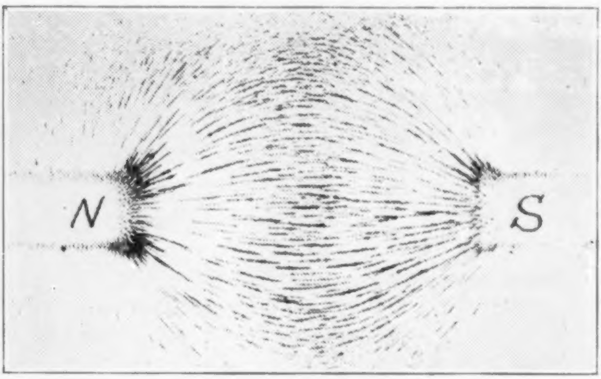

Figure 1. Arrangement of iron filings between two unlike magnetic poles—an attraction field.

In a second exercise the pupil studies the field between two like poles with the field between two unlike poles. This study is made with iron filings and the object is to familiarize the pupil with the appearance of the attraction field as shown in figure 1 and the repulsion field as shown in figure 2. The analogy of two steam pipes blowing steam towards each other and thus producing repulsion will help the pupil to see figure 2 as a repulsion field. If he can think of two other pipes placed in the same way but one being attached to an exhaust pump so as to pull towards it the steam emerging from the other, the analogy will be found helpful in visualizing the attraction field.

Usually there is no difficulty in leading pupils to see attraction in figure 1 and repulsion in figure 2 in which case the analogy is unnecessary.

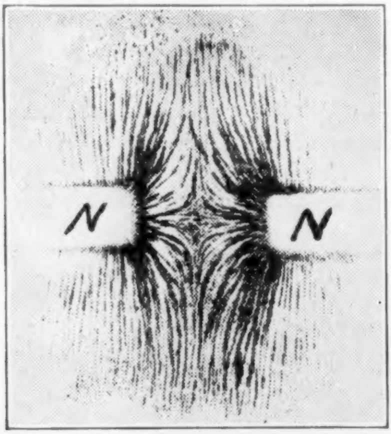

Figure 2. Arrangement of iron filings between two like magnetic poles—a repulsion field.

The third step consists in studying the field of three magnets placed as in figure 3. Figure 3 is similar to figure 1 except that a third magnet is laid across the field between the two unlike poles. The pupil should be able now to see two repulsions and two attractions all tending to cause counter clockwise rotation in the magnet placed across the field. His ability to see this will depend upon his previous study of figure 1 and figure 2. A few well directed questions will serve to clarify the situation: "How many repulsions do you see?" "If the central magnet were free to turn which way would the repulsions cause it to turn?" "How many attractions do you see?" "Which direction of rotation would they cause?" "How far would the magnet rotate?" "If by some magic we could change the poles of the short magnet when it becomes parallel with the field what would happen?"

There should follow a fourth step in which the magnetic effect of a current is studied. The important thing to learn here is that an iron core wound with insulated wire becomes a

magnet when current passes through the wire and that the poles are changed when the direction of the current is reversed. A series of easy experiments can be arranged so the pupil can find out for himself these facts or at least verify them.

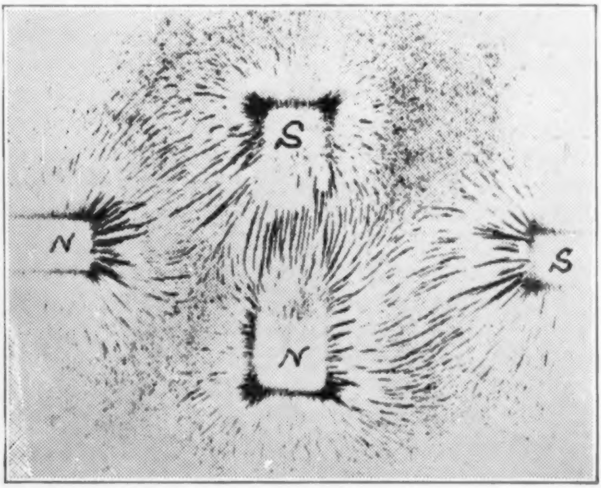

Figure 3. Showing how the magnetic field between two unlike magnetic poles tends to produce rotation in a bar magnet placed across the field. Note the two attractions and the two repulsions, all tending to produce counter-clockwise rotation.

Returning to figure 3 it can be easily seen that if the permanent magnet is replaced by an electromagnet supported so it can turn easily, we are on the way to producing continuous rotation. All that is lacking is a device for getting the current into the electromagnet while it is rotating and an arrangement by which the current will be reversed at the proper time.

The simplest apparatus for this purpose that I have found is shown in Figure 5.

The electromagnet serving as the armature is a piece of iron rod about five eighths of an inch in diameter and about five inches long. It is bent slightly at the middle so as to lower the center of gravity and is wound with number 18 insulated copper wire, the two ends of the wire being brought to the middle of the rod, bared and made to stand upright. A little tape or cord will serve to hold these wires in place on the upper side of

the rod. The rod is then supported on the point of a phonograph needle, sunk into the top of a wood support as shown in the drawing. To the positive of one dry cell and the negative of another are fastened short pieces of number 22 copper wire. These wires, which are to serve as brushes, must have the insulation removed from the part that comes in contact with the upright wires. The latter serve as commutator and of course must stand close together and directly over the needle support. Another wire is used to connect the remaining positive of the one cell to the negative of the other and thus close the circuit.

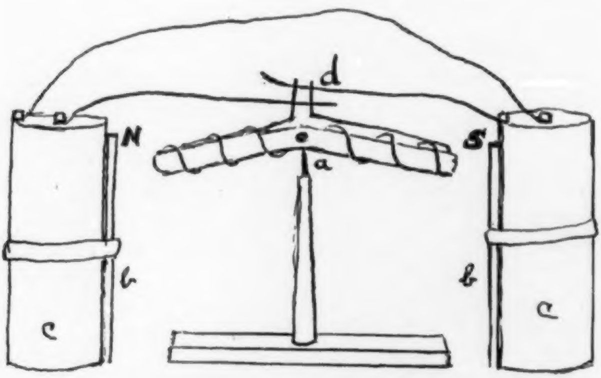

Figure 4. (a) Phonograph needle mounted in wood support. (b) Bar magnets. (c) Iron rod armature. (d) Brush wires in contact with upright wires serving as commutator.

Finally two bar magnets are fastened one to each of the dry cells. These are best held in place by two rubber bands. If now the connections are made as shown in the drawing the armature will turn when the two brush wires are brought in contact with the commutator wires. If the brushes are kept in contact too long the armature will rotate faster and faster until it jumps from the support. This can be prevented by turning one of the cells so that the contact at the brushes is broken when the rotation becomes too fast. Pupils will be able to understand better if the rotation is kept at a reasonably slow speed.

If now the magnets are removed and held in the hand some interesting experiments can be performed. While the motor is rotating the poles may be reversed and the effect observed. One magnet may be removed and the motor will continue to rotate

due to the effect of the other. The magnets may be moved up near the armature and then removed to some distance and the effect of distance noted. The position of the magnets may be changed around the armature and pupils asked to explain why the rotation depends upon the position of the magnets. Finally the magnets may be removed to another part of the room and the motor set in a north and south direction. The motor will rotate due to the earth field. To verify this conclusion turn the motor east and west. It will stop.

Following the experiments pupils should be assigned to the making of two drawings similar to figure 3. One of them should have its poles so marked that clockwise rotation will result and the other marked so that the resulting motion would be counter clockwise. A commercial motor or at least a practical motor should be examined and its parts identified with the simple but inefficient parts of the demonstration motor. It is not difficult to show why the drum armature is better than the rod but that it involves the same principles. Without going into technicalities of winding it can be shown that permanent magnets are not used in the practical motor but that the field magnets are electromagnets. Our study of electromagnets has prepared the way for this. Usually there are several in the class who can bring to the class a toy motor or some kind of a discarded motor which will add to the interest. Then of course, as indicated in the first part of this paper, much good will result from the study of the many uses of the motor and how it has transformed the work of the home as well as that of the mills and factories.

Teaching Materials for Elementary Science

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One of the studies made in connection with the curriculum construction work on the new elementary science course for Cleveland has not only brought out the fact that this country is at work on the curriculum but it has definitely shown that a large percentage of the cities are revising or preparing new courses in elementary science. This report shows that by the time courses are completed, 72% of the cities will be doing definitely planned work in Elementary Science and Nature Study.

This large number of cities with new and revised courses in science clearly shows the interest in this field of subject matter; but much work must be done before this vast field of subject matter will be adapted to the needs of the pupils in our schools. The place which elementary science will continue to hold along with the other subjects of the curriculum depends along with other factors upon the organization of objectives and activities and definite plans for supplying materials for classroom use. Do the objectives of your course in science represent the interest and needs of the pupils for the age in which they have been included in the course? Are the necessary materials provided in connection with each objective? In such courses as The Course of Study in Horace Mann School, The St. Louis Course and the Cleveland Tentative Course you will find the activities and materials listed for each objective. If the objectives and activities represent the needs of the elementary school, then the materials may be organized to meet these needs.

It is a comparatively easy matter to list the materials in a course of study; but for the classroom teacher with the already numerous problems and projects, this is just one more task. While the course is being made and tried out, materials should also be gathered and placed in sets suitable for each unit. Where and how may the necessary materials be obtained? Is the course so planned that materials may be obtained at the time of year they are called for in the unit of instruction? How may live animals be obtained for study in such units as the

rabbit and the frog? How may the materials for the phases of physical science such as the motor and the radio be obtained? These and many other questions arise in connection with the elementary science work.

Materials Obtained from the Local Dealers and the Home

If materials do not seem to be easily obtained the tendency will be to read about things and have a lesson of mere words. For example, pupils may read about an electric motor and its parts but not see it at the time. This procedure may or may not mean anything to them. On the other hand, have the pupils bring in two pins, four nails, one cork, a block of wood and about seven feet of copper insulated wire No. 20 and make a motor. The boys will be glad to go to the junk yard for the U magnet and the two dry cells may be bought from the local dealer. In Science and Invention School Service Bulletin for April 1927 and Nov. 1928 you may find a report by the pupils of the activities and materials for making a motor of this kind. It will not be necessary with this procedure to urge pupils to read in order to understand the motor; but they will be begging to come early and stay late to work and read about their motor.

It may seem like a difficult task to gather all these materials for the motor; but once you have done this work it will be a comparatively easy matter to have the materials when they are needed for the lesson next time.

There are other sources for materials for the lesson on motors such as the Educational Museums, The Supply Houses, the General Storeroom of the Board of Education, the industrial exhibits and booklets. The Educational Museum in Cleveland supplies electric motors which may be used to make a comparison of the commercial motor and the one made by the pupils. The dry cells should be available from the Educational Museum or from the general storeroom in the same way that physics apparatus is available for the high school.

The Work Desk

In connection with the physical science phases of the elementary science work it is desirable to have a small desk with water, gas and electricity for pupils' use. This desk may be in the science room or the regular class room and need not be an expensive piece of apparatus.

MATERIALS SUPPLIED BY MUSEUMS

For some units such as the one just mentioned it is much better for the pupils to help find the materials; but there are certain materials which it is impossible for pupils and teacher to supply. Such materials as lantern slides, mounted pictures, exhibits and motion pictures are supplied from the Educational Museum in Cleveland and other large cities.

The visual materials for several units of the Cleveland Tentative course as they are supplied by the Educational Museum are given:

CLEVELAND TENTATIVE COURSE

Fourth Grade

Fur Bearing Animals

Visual Materials:
1. Lantern Slides: Fur-bearing animals, the beaver, seals.
2. Mounted Pictures: Fur-bearing animals, the beaver, seals, musk-rat.
3. Exhibits: Beaver, log, fur.

Animal Friends—Dogs

Visual Materials:
1. Lantern Slides: Dogs.
2. Mounted Pictures: Dogs.
3. Film: Dogs.

The Quail and Other Game Birds

Visual Materials:
1. Lantern Slides: Quail, game birds.
2. Mounted Pictures: Quail, game birds.
3. Mounted Specimens: Quail.

Fifth Grade

Household Insects

Visual Materials:
1. Lantern Slides: Household insects.
2. Mounted Pictures: Household insects.
3. Exhibits: Household insects.

Sixth Grade

Game Animals

Visual Materials:
1. Lantern Slides: Fur-bearing animals, squirrels.
2. Mounted Pictures: Fur-bearing animals, squirrels, rabbits.
3. Mounted Specimens: Rabbit, squirrel, muskrat.

Telephone

Visual Materials:
1. Lantern Slides: Telephone.
2. Film: How telephone works.
3. Exhibit: Telephone.

For the lessons on tops the pupils may bring in their top and make a top but along with this the Educational Museum will supply lantern slides and the extremely interesting device the gyroscope with which the pupils may do may do many interesting tricks. When the lesson is completed the gyroscope is returned to the museum and is available for another school in the city.

The Natural History Museum

In some of the large cities museums such as the Field Museum of Chicago have made up exhibits which are distributed to the public school in connection with the regular science work.

Trips

In order to give the pupils concrete experience it is desirable to take classes into the field for study at times. The parks and vacant lots offer an excellent opportunity for the study of trees, weeds, insects and so on; but much time will be wasted unless a definite procedure is planned. Of course you will find many things which could not be planned for but the teacher should be sure of finding certain things to make the trip worth the time of going and returning.

Trip to certain industrial plants may be taken in connection with the study of such topics as airplanes, ships and so on. In some cases classes may be taken to a farm for a half day of study of plants, animals, and machines. Trips of this kind are valuable aids in giving the pupils concrete experience

In connection with the study of fur bearing animals it will be helpful to make a trip to the Zoo if the school happens to be in a larger city where a Zoo is maintained. In large cities one or more trips may profitably be made to the Natural History Museum for the study of material which can not be conveniently sent out to the schools.

Live Animals and Plants

Living animals are essential materials for the elementary science work in all the grades and some plan should make real live animals available in connection with certain lessons. The problem of obtaining such materials is vital to the science work.

In some cases living animals such as snakes, turtles, frogs, snails and insects will be brought in by the pupils. These animals should be placed in cages which will help make them com-

fortable or they should be given their freedom at once. The cages may be nothing more than store boxes with wire netting over one side or they may be the cages made for this purpose by the dealers in laboratory supplies.

The pupils should be urged to make notes of the habitat in which the animals were found in order that they may use this information to help make the animals comfortable in the school room. It is important that the pupils try to make the animals comfortable and provide them with food and water. Here the animals will be available for individual study for some time.

Some animals such as squirrels and raccoons may, be kept for some time as pets; but in the case of most animals it will be better to dispose of them soon after the study has been completed. This will eliminate the possibility of discomfort on the part of the animals and minimize the work of the busy teacher.

In the larger cities it would be difficult for the teacher, or pupils in some schools, to obtain some of the animals needed for certain lessons, such as toads, frogs and turtles. For other lessons domesticated animals such as the canary bird, doves, rabbit and guinea pigs are needed. It is not only a problem to obtain such animals; but in some cases is just as much of a problem to dispose of them.

In Cleveland we are working on a plan by which the schools may buy the animals from certain dealers for their science lessons. The school may keep the animals one week or several months until they no longer need them. Then the dealer will buy them back at one-half the original sale price. In most cases this would be a reasonable rental fee when you consider the number of rooms in a building which could use the animals. This plan eliminates the responsibility of caring for the animals through a summer vacation and over long periods of time when the animals are not needed.

While the animals are at the school the pupils may care for them and study their habits. The wise use of living animals will be a great help in the elementary science lesson.

Plants are more easily obtained and cared for in the ordinary school room. In some of the large cities the garden departments aid in supplying certain materials for garden clubs and the growing of bulbs.

THE SCHOOL MUSEUM

In schools where the school museum or room museum has been tried it is hailed as a success. In such a museum though small may be found some rare treasures presented by an individual pupil in the school. The school museum will stimulate the pupils to bring in materials of the neighborhood. Many of the collections are an outgrowth of the work on different topics such as leaves of trees mounted and labeled, fruits and seeds mounted in boxes with low sides and labeled and rocks and mineral of the vicinity.

The following specimens have been used in Sterling School, Cleveland. This list was suppied by Elizabeth Regan, Principal.

SPECIMENS IN SCIENCE CABINETS
(Many duplications in different rooms)

Leaves. Sycamore, oak, catalpa, sumac, buckeye, maple, apple.
Twigs.
Bark
Woods. All varieties—petrified woods.
Plans.
1. Edible.
2. Non-edible—cones, hemlock, spruce.

Nuts.
1. Edible—cocoanut, walnut, butternut, hickorynut.
2. Non-edible—acorns, buckeye, sycamore balls.

Plants.
- Whole.
- Part.
- Blossoms.
- Wild—bittersweet, wintergreen.
- Cultivated.
- Leaves.
- Seeds, milkweed, cat-tails, dandelion, stick-tight, fruit seeds, cockle-burrs, vegetable seeds, burrs, cotton-seeds, radish seeds, carrot seeds, sunflower.

Vegetables. Peas, beans, potatoes, carrots, beets, onions, radish, tomato, pumpkin.
Flowers.
- Cultivated.
- Wild—thistle, goldenrod, barberry, teasel.

Grains. Wheat, oats, corn, rice, barley, flax.
Fungi. Yeast, mold, toadstools, mushrooms, shelf-fungi, lichen, moss.
Cotton in all stages.
Feathers, various kinds.
Miscellaneous. Vanilla bean, coffee (ground, beans), cinnamon, tapioca, nutmeg, bran, sugar-cane, tobacco, tea, bamboo, mustard, pepper, ginger, cocoa.
Minerals. Coal, copper, flint, iron, zinc, quartz, sandstone, lead, slate
Stones and rocks of many kinds.
Marble—many varieties.
Seaweed.

Fish.
Living—goldfish, sword tails, guppies, platties.
Star-fish—beak of sword-fish.
Wool—in all stages.
Leather.
Silk.
Furs—all kinds.
Turtle.
Guinea Pig.
White Rats.
Rabbits.
Insects—various kinds—cocoons.
Grasshopper.
Spider.
Beetle.
Worm.
Shells.
Rubber.
Wire—insulated—un-insulated.
Pearl.
Celluloid.
Snake—skin, rattler.
Boar tusk.
Frog's Eggs.

From all these materials the teacher and children may select materials at the end of the year which may be kept as a nucleus for the mueum next year. The collecting and labeling and sorting are activities which will give the pupils concrete experiences with the materials in their environment.

The materials which have been arranged for the science work may also be used in connection with the language lessons. Pupils may write letters asking the pupils in other parts of our country to exchange articles for the museum. In this way schools in Cleveland may obtain such specimens as cotton, holly and so on.

This little museum will not in any way detract from the interest in materials from the Natural History Museum or the Educational Museum, but it gives these large museums a greater significance to the work which the pupil is doing.

The little room museum is a means of taking care of the occasional materials which pupils bring in from time to time and which should receive some attention from the group but cannot conveniently be used for a lesson at the time.

The museum may be nothing more than a store box with shelves for the first year. Later more elaborate cases may be provided as they are needed. I can direct you to such a simple case in one of our city schools which means vastly more to the children in that room than the exhibits in fancy cases which are enclosed in glasses so the children cannot touch them.

SCIENCE READERS AND MAGAZINES

There has been some attempt at producing textbooks in science and supplementary science readers but up to the present time there are few such books available.

With each unit in the Cleveland Tentative Outline of Elementary Science the committee included the books best adapted to the grade for the pupil and the teacher.

The objectives, activities and visual materials are omitted and only the reference materials about which the unit is organized are shown in the following excerpts:

Fourth Grade

Fur Bearing Animals

Pupils' References:
1. Hawksworth, Hallam—The Adventure of a Grain of Dust, pp. 146-161.
2. Mills, Enos A.—In Beaver World (good illustrations), entire book 220 pages.
3. Schwartz, J. A.—Wilderness Babies.

Teachers' References:
1. Harding, A. R.—Fur Farming.
2. Roberts, C. G. D.—The House in the Water (a good beaver story.)
3. Long, W. J.—The Ways of Wood Folk, pp. 77-100.
4. Nelson, E. W.—Smaller Mammals of North America.
5. Stone and Cram—American Animals.
6. Burroughs, John—Squirrels and Other Fur Bearers.
7. Dugmore, A. R.—Romance of the Beaver (entire book, splendid illustrations).
8. Richardson, A. G.—Beaver—King of the Grizzlies—Wildwood Tales.

Fifth Grade

How To Tell Time

Pupils' References:
1. Horn, E.; McBroom, N.—Learn to Study Readers, Book III, p. 81.

Teachers' References:
1. Van Buskirk, E. F.; Smith, E. L.—Science of Everyday Life, pp. 69, 317.
2. Trafton, G. H.—Teaching of Science in the Elementary School, pp. 179-180.
3. Bearley, H. C.—Telling Time.

The periodicals cannot be listed for each unit in a course because of the changing content from month to month. Some of the magazines which contain interesting subject matter for use in the elementary science work are the following:

Nature Magazine, Washington, D. C.
Bird Lore, Audubon Society, Harrisburg, Pa.
Science and Invention—The Experimenter Pub. Co., New York.

Science and Invention School Service Bulletin—The Experimenter Publishing Co., New York.
Popular Science—Popular Science Publishing Co., New York.
The Science Classroom—Popular Science Publishing Co., New York.
Popular Mechanics—Popular Mechanics Press, Chicago, Ill.
National Geographic Magazine—Washington, D. C.

INDUSTRIAL MATERIALS

Booklets—In the preparation and trial of certain units of the Cleveland course, the lack of reader with subject matter dealing with phases of the physical science was experienced. Until readers are produced which adequately meet the needs of all the phases of subject matter which are included in elementary science, certain materials produced by commercial firms will help meet this need. Such booklets as "The Magic of Communication," "The Birth and Babyhood of the Telephone," published by The American Telephone and Telegraph Company, "Something About Sugar," by the California and Hawaiian Sugar Refining Corporation, "Dry Battery Handy Book" (A Primer of Electricity), by National Carbon Company, the booklet on "Gyroscopes" by the Sperry Gyroscope Company, and others which appear in a list recently published for teachers' use. Science and Invention School Service Bulletin will help meet this need.

In most of this material the vocabulary has not been adapted to a particular grade, but most of the booklets may be used for the intermediate grades.

INDUSTRIAL EXHIBITS

Another type of materials supplied by commercial concerns is the exhibit showing materials used in everyday life with the different stages in the manufacture of the product. Such an exhibit as that by the Elgin Watch Company, showing the parts of the watch is valuable for the lesson on the telling of time.

The pictures of electric locomotives and trains by The Chicago, Milwaukee and St. Paul Railway are valuable in the lessons on transportation.

The complete list of available materials of this kind has been made up after much correspondence and the materials classified in groups suitable for elementary science, Junior High School and Senior High School Science.[1]

1 Science and Invention School Service Bulletin, June 1928, July 1928

DEPARTMENTS OF NATIONAL AND STATE GOVERNMENT

Teachers and pupils may obtain much excellent supplementary material from the various departments of the National Government. The Department of Agriculture offers many Farmers' Bulletins and Department Bulletins which contain subject matter for many lessons in Elementary Science. Such bulletins as "The Muskrat" and "The Beaver" contain excellent illustrations and information on these topics.

The Bureau of Biological Survey and the Forest Service have available many bulletins which will be useful for lessons in science. The State Agricultural College and the Experiment Station will send bulletins upon request. Such publications are the bulletin "About Wild Flowers," published by Ohio State University and "Destructive Insects Affecting Ohio Shade Trees," by Ohio Agricultural Experiment Station.

Teachers should write to these departments for a list of the available publications and order from the list those which they can use in their work.

OTHER SOURCES OF MATERIALS

Materials may be obtained from the following sources free or at a reasonable price:

American Nature Association, Washington, D. C.
  Bulletins and reprints.
National Association of Audubon Societies, New York City.
  Bird Pictures and Leaflets.
The Grolier Society, New York City.
  Lessons and Pictures.
National Wildflowers Preservation Society, Washington, D. C.
The Living Tree Guild, New York City.
  Spruce Trees.

I have outlined the ways and means of obtaining materials for science lessons and emphasized the importance of such materials for the elementary science work. It will require some time after the science course is completed for the museums to prepare suitable materials and for teachers to become familiar with the materials and their sources; but the use of such materials is sure to mean a much-enriched experience for the boys and girls in our schools.

The Teaching of Science

Lewis B. Avery

Director of Science, Oakland, California

There are at present three acknowledged divisions in the teaching of Science in the public schools:

1. Science in the high schools, where it is given under the captions of the various subjects of Science, from which are generally omitted any tudy of Astronomy and Geology. The remaining sciences are seldom all taken by any one pupil. Hence, only a very partial view is possible.
2. General Science, which has been struggling to find itself for the past ten years or more, but has not yet arrived at any clear definition.
3. Nature Study—an older phase of Science teaching, perhaps beginning with Rosseau's excursion "back to nature."

It is doubtful whether teachers generally separate clearly between these fields of Science. The high school sciences are thoroughly standardized in so far as their various fields are concerned. Nature Study is generally interpreted to be a rather indiscriminate study of common plants and animals. General Science, covering a field between the other two, has been aimed to meet the prevailing ignorance of things scientific through various methods.

The high school sciences have been perfected as technical subjects taught in a technical way by technically prepared teachers. Pupils entering high school have little basis in their own observation or experience to determine what particular sciences they should undertake to study. They have ordinarily had no experience on which to base their interest in the subject. They are not at that time ordinarily ready to determine the applicability of the various subjects to their own proposed life work. Preparation for the university or the reports of their older school mates are largely the determining factors. It thus happens that while the high school sciences have arrived at a high degree of perfection in their arrangement and presentation from the subject point of view, there has been a steady decrease in the number of persons

taking these subjects until the most expensively equipped academic department in our high schools has the smallest attendance; but the worst feature of this situation, and from any large educational standpoint a truly alarming one, is that at a time when the world is ruled by science, and scientific specialists are required to keep civilization in its proper course; when science is applied hundreds of times daily to the life and comfort of every citizen of a great city, the average citizen knows practically nothing of it excepting what he has gained from the Sunday supplement or by shrewd guesses based on actual contact with the movement of affairs about him. At a time when the scientific expert is in the saddle, the average citizen is wholly unable to distinguish between real scientists and pseudo-scientists. There was a time when 14 weeks in this science and 14 weeks in that was popular in the high schools of the country and our young people had quite general scientific information and very great scientific interest even though it may have lacked in depth and accuracy, but science then was somewhat of a Fairyland, which of late it has ceased to be. It is time that young people were generally made acquainted with the fundamentals of science, the facts and laws of their environment and the natural and applied forces among which they are to live and over which they may hope to obtain some command.

THE STUDY OF ENVIRONMENT

Nature Study has for many years been accepted by makers of courses of study as a waif that must be cared for but apparently no one has known exactly how. At all events those who have proposed ways and means have been unable to obtain results for any length of time and in most cases, if not all, Nature Study courses in city school systems are more honored in the breach than the observance. This does not mean that there are not enthusiastic teachers of Nature Study, but these ordinarily teach the subject in spite of the course of study rather than according to it. This is partially due to the fact that the world is so full of a number of things, that when any group of individuals undertakes to select from the field of nature those things that shall be studied and thereby exclude the remainder and apply it as a required

course of study, it fails to function. The reason for it may generally be found in that the course which a given grade is expected to follow does not deal with the actual surroundings of the pupils, or the teacher who is expected to teach may not know and appreciate the things she is to teach. Generally both of these conditions prevail. For a time the conscientious teacher attempts to drag in from a distance a new and strange environment and acquaint the children with these things concerning which she knows little and cares less. Let us clear the decks by saying that what is done in the grades below the 7th for so-called Nature Study should be replaced by the study of the actual environment of the pupils at home and at school. In bringing in more remote material, only such as can be connected up with what they are doing or reading should be considered. The things studied should be those in which the pupils are interested or may be made to interest themselves. It is evident these cannot be specifically stated for a whole city; that it becomes the business of the teacher to assist in the determining among the many things that will be presented those which are most significant. Thus Nature Study is enlarged into the study of environment, which may included as much of nature as may excite real interest and curiosity. The wise teacher will have a plan, but a flexible plan; will see the work connected and not fragmentary, but will not let either the plan or the method dull the edge of real interest.

General Science

General Science has been a separate subject in the curriculum for but a short time. It has been and still is confused more or less with Nature Study on the one side and with the various sciences on the other, and it is doubtless a question in the minds of some as to what right it has to a separate name—whether it has a separate definition and a separate function to perform in the curriculum. First of all, General Science has been thrust into the upper grades of the grammar school and the lower grades of the high school and has more or less partaken of the characteristics of Nature Study on the one hand and of the Sciences on the other. The method of study has been tried which is peculiarly the chief method of Nature Study, or the eclectic method, which takes a little from this science and a little from that, but in sepa-

rate compartments, and is merely a reflection of the high school sciences. Physical Geography was for a time used as the organization core with a considerable expansion of the portion that treats of natural pnenomena, but this failed to cover the necessary ground or turn the subject from its real physiographic aim.

It should be noted that the growth of General Science comes at a time when nature has been applied in a remarkable way to the promotion of human interests in the group life of men. It thus chances that in the cities children meet applied forces very much more frequently than they do nature unmodified. All the means of living in great groups are the product of applied natural forces. Through the channels in which these have been applied one may read back to nature itself, and this suggests the fact that the most adequate organizing channels around which the phenomena of applied natural forces may be grouped are the ones that men have used to protect and promote individual and public interests. While these channels overlap, yet they may be named approximately as follows:

1. Health and Sanitation—for the protection of the human organism.
2. Shelter and Clothing—for protection from the elements.
3. Food—for the nourishment of man.
4. Lighting—by means of which he is able to turn night into day and carry the sunlight where he pleases.
5. Heat—by which he not only makes himself independent of climate, but which he uses as his servant in conquering many of the materials of nature.
6. Communication—by which the thoughts of each individual may be transferred to all parts of the globe.
7. Transportation—by which he makes the entire earth his home.

The wheels of the factories move that man may be served through some one of these channels. They are the highways along which a teacher may lead his pupils and pick out from either side those things which are of greatest interest or moment, worthy of appreciation, or needing interpretation. These highways wholly disregard the partitions which have been built up between sciences. Around these each teacher may frame his work with reference both to what the experiences of the individual taught may be and the abilities that the teacher himself may have to explain and interpret. So many people are strangers to their surroundings, even in their own home. The ordinary appurtenances of the house are a mystery.

Everything mechanical is strange to them. Fact and fancy are hopelessly mixed in the realm of health and disease, and as for the natural phenomena about them, they many times know less of trees and flowers, less of the earth under their feet and the sky above them than people did in the days before science had begun its revelations. The General Science course is the one possible means by which all people may be reached. It is of the utmost importance that a clear and adequate method be employed.

My attention was called, not long since to an article, the title being, as I remember it, "The Dumbbell Age." The article undertook to show that instead of this being an age that requires a higher degree of education than formerly, all one had to do was to push a button or turn a switch. It is the chief mission of general science to establish a rational interest in what is behind the button and the switch, so that the laws of health and sanitation may not be mere recipes, that shelter and clothing may not be represented merely by end of the month bills, and so through the list. The function of General Science is not to establish the field of any particular science, but to open clear pathways to all of them.

It is very certain that no individual can learn or teach all that is to be learned or taught. It is hence necessary to supply a rational means of selection. These seven channels to which possibly a few others may be added, furnish to the teacher the means of determining what he shall teach to the group that he has in hand. Into each field he can go as far as circumstances demand and return at will to his central theme, his aim, to keep young people from being content with being a contributing part of a "dumbbell age."

Suggestions to Pupils for the Study of Natural Sciences

W. J. Klopp

Woodrow Wilson High School, Long Beach, California.

1. Equip yourself with the necessary tools for class and laboratory work. They should include text book and manual, ruler, pencil, compass, protractor, graph paper, plain paper and such other tools as the course may require.
2. You should never attend a science class without these tools.

3. Every good teacher plans the course in science for the semester, hence every daily assignment is a part of this plan and you cannot afford to miss a single part. It is therefore very important that you keep an accurate record of every assignment.
4. When you prepare your lesson observe suggestions:
   a. Find a quiet place to study where you have good light and air.
   b. Read over the assignment and select out the most important points to be discussed; write them down and then try to explain them and give practical illustrations.
      1. Suppose you were studying the structure and function of a flower: collect several kinds of flowers and study their structure; this will make it easier to remember as well as to understand.
   c. Whenever the teacher gives a demonstration, make up your mind that he is trying to simplify a law or principle for you and this should be a cue for you to draw the apparatus, label every part, and make notes concerning the principles to be illustrated. Use this as reference then for the preparation of the new assignment.
   d. Never allow interruptions during your study period.
   e. It is frequently valuable aid to collect clippings and articles illustrating topics under discussion in the new assignment.
5. When you report for laboratory work, the following simple rules will help you in your work:
   a. As soon as the bell rings get out your equipment and get ready for work.
   b. Get definitely in mind what problem you wish to solve or what law or principle you wish to verify.
   c. Set up the apparatus and begin making accurate observations and recording data, ever remembering that the accuracy of the results depends upon the accuracy of data recorded.
   d. Write out your findings and conclusions in an orderly and neat way.
   e You should be able to complete the collection of data and making a record of your observations before the period ends.

f. Use the following plan for making record of an experiment or demonstration:
   1. Title of experiment.
   2. Object of experiment.
   3. List of materials used in the experiment.
   4. Make a drawing of the apparatus set up for the experiment and label each part carefully.
   5. Tabulate the data and state briefly all observations.
   6. Discuss the findings in the light of the data as related to the object of the experiment.
   7. Write out the conclusions and explain all possible causes of the errors.
   8. Sign your name and give the date of the experiment.

g. Be content with nothing save the best results possible; take many readings; be neat in all your records, use good logic and a strong vocabulary in your reports of experiments.

6. No pupil is allowed a grade unless the assigned work is completed at the close of each semester. This means that you will receive either a failing or incomplete grade if the work is not all in.
7. You cannot remove an incomplete grade except by repeating the course or taking a special course in another school and secure the signature of the instructor and get the work approved by the supervisor and pupil.
8. You will find great danger in trying to memorize a group of formulas or laws or principles or theories unless you can apply them intelligently to problems or experiences. It is far better to study each law or formula or principle until you understand and can illustrate it.
9. Independent and thorough work is the only assurance of success in the field of science.
10. If you find the work of the class too easy be sure to ask your instructor to give you more difficult problems and more complex experiments; it will add to your equipment and skill as well as to your interest and scientific spirit.
11. There is greater joy in knowing that you accomplished a task unaided, though it be simple, than in getting praise for work not your own.
12. Take the best of care of the equipment in the laboratory and aim to leave it in as good shape as you found it. Do this for the "other fellow, who will follow you."

13. Aim to keep all experiments and demonstrations in your note book and in the order in which you completed them so as to simplify the work of frequent review. At the close of each semester make an index of the work in the notebook for quick reference. This index may be started after the first day.
14. Keep a list of new terms in science and become familiar with them so as to use them in your written and spoken discussions.
15. In doing your work faithfully and well yours may be the reward of realizing the following objectives.

To give intellectual training in grasping the abstract or theoretical.

To cultivate the powers of observation of the pupil.

To impart certain useful scientific knowledge for those not going on with further science work in school.

To give training in the formulation of recreative interests in the pupils.

To develop the pupil's sense of responsibility and power of carrying things through by himself.

To train the pupils to utilize their capabilities and abilities to the fullest extent.

To educate the child for the present life.

To educate the child for his own and his community's health.

To educate the child for intelligent citizenship and proper solution of civic problems that he will meet.

To develop the aesthetic values of science in the student.

To free the pupil from superstitions, undue fears, tangents, extremes, and so forth, by a basis of usable facts.

To understand and utilize the familiar facts of daily experience and environment.

To become acquainted with and make habitual the scientific method and thought.

To give an introduction or entrance to the various specialized fields of science.

To train in the defining of problems which arise and in solving them scientifically.

To develop in the student proper ideals, habits, tastes, attitudes, appreciations, and bring out the moral values involved.

To have some understanding and appreciation of the various phenomena of nature.

To understand, appreciate, and to some extent inculcate in their own lives the true scientific spirit.

To base the study of science upon psychological divisions, which are in turn based upon the needs and interests of the pupils.

To serve as an introduction to the whole field of science as a whole or unity.

To develop the vocational and utilitarian values of the various activities of science.

To arouse interest in science in the pupii from the standpoint of the amateur or consumer.

To develop the social and civic values of science.

To give sufficient insight into science to act as an educational and vocational guide for the pupil.

To develop faith in the worth of the problems attacked and in the possibility of solution of them.

To develop the desire to learn more about things scientific.

The Evolution of the Match

C. W. Garman,
State Teachers College, East Stroudsburg, Pennsylvania

A playlet serving as a centralized activity involving the cooperation of a whole school.

It is primarily a science project which portrays the history of fire-making from the beginning of time. There are three acts and each setting shows the environment, activities and dress of people separated by centuries.

There is an interlocutor who takes a position at a corner of the stage and directs the play and explains the performance to the audience.

He tells the audience the story of fire-making and its uses during the progress of civilization and then states that he will close his eyes and visualize the activities of his ancestors.

Act I. Scene I.

The interlocutor drops into an easy chair and falls asleep and dreams.

A blare of crude and unearthly music bursts forth from tom-toms, horns, sea shells, etc. (accompanied by a piano to control the rhythm). The saxaphone and flute are valuable aids though these instruments are concealed from view as they are chronologically out of place.

The curtain rises and the audience beholds a cave in the side of a cliff. Dogs are tied at the entrance and there are bones and skins much in evidence all about the cave. Some are real and some are painted upon the scenery.

Primitive men emerge from the cave shouting and arguing as they are about to join in a hunt.

They are dressed as primitive savages with long, tangled hair (dyed hemp) and fur bodices (made of dyed and frazzeled jute sacks) while their fair arms and legs as well as faces are streaked with brilliant paints (red, yellow, black and white). They carry clubs and stones and spears. (Six or eight large boys act as savages.)

The argument sets forth the nature of the hunt and methods to be used in outwitting the animals.

The argument results in a free-for-all fight which is quickly

terminated by the big and powerful chief who explains just what animals they will hunt and how they will capture the prey decided upon.

There is a cheer of approbation after the chief's remarks then they join the chief in a primitive dance in front of the cave.

They dance away toward the forest (off from the stage) and the curtain falls.

ACT I. SCENE II.

Curtain rises. Savages come home yelling and dancing and carrying their game (artificial deer or any other game.)

Now comes the preparation of the feast which involves the making of fire by striking flints and steel together. (This is difficult and requires much previous practice. Some gunpowder will help to save time and avoid failure.)

The fire is kindled upon a large pad of asbestos.

As the savages bring the game toward the fire the curtain falls.

ACT II. SCENE I.

Interlocutor arises, stretches, yawns and rubs his eyes and then states that he would like to visualize the activities of his ancestors when they used the bow-and-string method of making fire by friction.

He explains to the audience just how it was done, what materials were used and what the difficulties were. He suggests that he will continue his dream and drops into his chair again and falls asleep.

Indian music now bursts forth. (A modern orchestra renders the music though the tom-toms, drums and saxaphones predominate.)

Curtain rises and the audience beholds a beautiful Indian village with tepees, totems, costumes, dogs, bows and spears. A kettle is mounted in middle of the scene where the Indian maidens are preparing for the noon meal. Corn, beans and dried beef are much in evidence.

The braves engage in a lively war dance for a few minutes.

The Indian wedding dance as well as the funeral dance is very striking.

An Indian maiden emerges from a tepee and sings the Indian love song.

A squaw asks the chief to have a fire kindled. He summons

a few braves and commands them to kindle a fire. They proceed with their bows and strings to rotate sharp sticks upon some dry chunks of wood and thus produce a fire which is placed upon the asbestos pad under the kettle. (Use the regular scout method.)

The Indians move about the stage, some eating morsels of food, others playing with the dogs, others examining their weapons.

A warrior falls in love with the maiden while she is singing the love song.

He moves shyly over to her side and placing his arm about her, joins in the song which becomes a beautiful duet.

The curtain falls.

Act III. Scene I.

The interlocutor arises and explains how modern matches are made and how they have been improved during the past few years.

He exhibits a few matches which have been made in the General Science class and explains how they exemplify the matches which were made about a century ago.

He explains the modern devices for lighting the gas and also the ignition in an automobile.

He comments upon the great advantages we have in living in this age and this great country of ours.

The entire cast joins in singing the Star Spangled Banner.

Curtain falls.

This playlet was staged at Teachers College, East Stroudsburg, Pa., with marked success.

The following departments cooperated with the Science Department to put on the play: Manual Arts, Music, Art, Dramatics, English and Physical Education.

The New Books

The Technique of Research in Education—1928—C. C. Crawford—320 pages—University Southern California Book Store.

This book was written in the hope that it might be used as a text to prepare for entrance into graduate study and research.

A few of the seventeen chapter titles are—Selecting Problems; Experimental Technique; Psychological Technique; Survey Technique; Job Analysis Technique; Interview Technique; Analysis and Interpretation Data; Report Research.

Each chapter is followed by a set of "Exercises and Questions," and a bibliography of reading for library work.

Fundamentals of Human Motivation—1928—L. T. Troland—521 pages—$5.00—D. Van Nostrand Co., Inc.

This book is, we believe, the first to give in a psychological text an adequate and comprehensive treatment of human motivation. It discusses: 1. Our inborn tendencies to action; 2. The means by which we learn; 3. The basis of "pleasure and pain"; 4. The foundation of "happiness" in general; 5. The nature and operation of "instincts," such as that of sex; 6. The physiological meaning of the Freudian "complex"; 7. The nature and formulations of emotional experience; 8. The explanation of typical modern interests, automobile, radio and the like; 9. Suggestions toward a scientific treatment of problems of ethics.

Teachers of all subjects will find this volume one that offers many helpful suggestions. It should be placed in your library and read more than once.

Fruit Growing Projects—1928—F. C. Sears—383 pages—256 illustrations—The Macmillan Company.

This is a practical fruit growers' book for treating the fruits (excepting the citrus fruits) commonly grown for sale. It is a book not only for the student of vocational agriculture but for the commercial fruit grower as well. The amateur who grows a late fruit for his own use will find this book a good investment.

Food Products—Third revised edition—1928—E. H. S. Bailey and H. S. Bailey—533 pages—104 illustrations—P. Blakiston's Son and Company.

The rearrangement of this popular book has brought it up to date. It has practically all been rewritten and the new data obtained from men who are experienced. The book covers the important facts of source, chemistry, and use of those things which we eat and drink. It is a good text for Household Economics classes and reference book for General Science classes.

A First Course in Physics for Colleges—1928—R. A. Millikan, H. G. Gale, and C. W. Edwards—731 pages—678 illustrations—$3.72—Ginn and Company.

This is a text for beginners' course in physics in college, covering one year. It differs from other college texts in its lack of difficult mathematical treatment, which is seldom assimilated by the majority of students. It is strong in its fundamentals and its interesting present-day applications of physics principles.

The Engineer—1928—R. L. Sackett—196 pages—illustrated—$1.40—Ginn and Co.

The aim of this book is to acquaint those who are considering engineering as a life work with engineering as a profession, and

with college courses which will help in preparation for it. After considering the selection of a vocation and giving the history of engineering, separate chapters deal with such branches of engineering as civil, electrical, mechanical, industrial, chemical, and mining. An appendix gives brief biographies of engineers who have made history.

Mechanics for Engineers—1928—J. C. Smallwood and F. W. Konwenhoven—185 pages—$2.50—D. Van Nostrand Co.

By eliminating some of the less important subject-matter, greater emphasis is given to those problems which are of more importance to the engineering student. The book covers general principles, uniform rotation, center of gravity, forces, cranes and trusses, friction, motion, acceleration, work, energy and power, momentum, impulse and impact.

Laboratory Manual of Elementary Physical Chemistry—1928—Edward Mack and W. G. France—195 pages—40 illustrations—$2.00—D. Van Nostrand Company.

The selection of topics covers very well the wide field of physical chemistry, and the experiments are of a character to arouse and hold the student's interest. The amount of material given is about 50 per cent greater than can ordinarily be completed in a year. Hence, there is opportunity for selection.

Elements of Qualitative Chemical Analysis—1928—W. W. Scott—164 pages—$1.60—D. Van Nostrand Company.

This text covers the essentials for a one-semester course in qualitative analysis. It may be used for shorter courses by having the students begin with the group separations. Charts, tables, reviews, and summaries are used in an effective way to insure thoroughness.

Experimental Science—1928—J. W. Bispham—50 illustrations—70 cents—Oxford University Press, American Branch, N. Y. C.

This book treats many principles of mechanics and heat for junior students in evening schools who are likely to enter the trades. Many interesting experiments are described. The subject matter is on matter pressure in liquids, gases, density, equilibrium, simple machines, expansion, calorimentry, and transmission of heat.

Classroom Procedure Test in Natural Science—1928—H. A. Cunningham and Douglas Waples—10 cents each—25 copies for $1.25—The University of Chicago Press.

These tests are for evaluation of different teaching procedures by high school teachers, and consist of ten typical classroom situations. Five different ways of meeting each situation are suggested.

Laboratory Manual of High School Chemistry—1928—G. H. Bruce—101 pages—illustrated—76 cents—World Book Company.

This laboratory manual is supplied in both bound and loose-leaf form. It contains the standard list of college entrance requirements. Sixty experiments are outlined. A list of materials—chemicals and apparatus—requirements are listed at the back of the book.

Laboratory Manual for Third Edition of "A Course in General Chemistry" — 1928 — McPherson-Henderson-Evans — 165 pages—illustrated—$1.20—Ginn and Company.

This manual is for first-year college students. It contains text for ninety-five experiments. This large number of experiments makes it possible for the instructor to select for each individual experiments adapted to his needs, that is, for those who have had no previous chemistry and for those who have had an elementary course.

The Health of Youth—1928—Florence I. Merideth—535 pages—175 illustrations—P. Blakiston's Son & Co.

This text, written for the upper two years of Junior High School, presents a few discussions of the main health problems which should be brought before boys and girls of thirteen to fifteen years of age. Only such parts of physiology are introduced as seem necessary to a clear understanding of hygiene, which is defined as "the science and the art of healthful living." It is an attractive book, well written, and will fill a present need.

General Chemistry—Second Edition—1927—660 pages—124 illustrations—The Miner Publishing Co.

This is a text for college students written by eight college chemistry instructors. There are 40 chapters, covering the field of inorganic chemistry and including several chapters on carbon compounds, food chemistry, and colloidal chemistry. Each of the authors has written on those topics in which he is most interested, and that accounts, perhaps, for the interesting material which is presented and in the simplification of topics too often left obscure by the text.

High School Chemistry—1928—G. W. Bruce—550 pages—147 illustrations—$1.68—World Book Company.

This book is strong on the vital, fundamental facts, mostly theories, commonly included in a high school course. Relatively small space is given to the popular applications of chemistry. The modern electron theory is used to explain chemical reactions. Review and drill exercises are given at the chapter ends.

Junior Science—1928—C. A. Stebbins—352 pages—163 illustrations—The Macmillan Company.

Junior Science is an introduction to General Science, covering but a small part of the host of science applications close to the life of the child. It takes up the plants and animals and the natural phenomena of the child's surroundings. A list of suggestions of exercises and things to do—home studies—will keep the child intensively interested in his work.

A Student Laboratory Guide—General Science—1928—M. C. Collister and E. L. Thurston—143 pages—76 cents—Iroquois Publishing Co.

This laboratory manual contains directions for 100 experiments, including those required by the New York State Syllabus. It is a bound book with blank spaces for pupils' notes. A good list of projects are suggested for supplementary class work.

Science Articles in Current Periodicals

Air Travel
- Luxuries Aboard an Air Liner. Pop. Mech., 50:429, Sept. 1928.
- Dog Fighters of the Air. Pop. Mech., 50:434, Sept. 1928.
- Learning to Fly. Pop. Mech., 50:466, Sept. 1928.
- Flying Planes Without Motors. Pop. Sci. Mo., 113:2:28, Aug. 1928.
- Dick Byrd—Adventurer. Pop. Sci. Mo., 112:6:28, June 1928, and 113:2:50, Aug. 1928.
- The Greatest Overseas Hop: California-Australia. Pop. Sci. Mo., 113:2:19, Aug. 1928.
- Wrong Side Up. Pop. Mech., 49:957, June 1928.
- Motorless Ships of the Air. Pop. Mech., 49:888, June 1928.
- To Bogota and Back, by Lindbergh. Natl. Geog. Mag., 53:529, May 1928.
- Huge Flying Hotels. Pop. Sci. Mo., 112:6:32, June 1928.
- Real Flying Machines. Lit. Dig. 98:2:21, July 14, 1928.

Accidents
- Cause of Automobile Accidents. Lit. Dig., 93:3:18, Jan. 21, 1928.
- What Can Happen While You Wink Your Eye. Pop. Sci. Mo., 113:2:13, Aug. 1928.

Astronomy
- New Stars and the Rejuvenation of the Universe. Sci. and Inv., 16:412, Sept. 1928.
- From the Earth to the Moon in a Rocket. Sci. and Inv., 16:393, Sept. 1928.
- The Last Mystery of the Heavens. Pop. Mech., 50:266, Aug. 1928.
- Astronomy by Planetaria. Am. City, 38:6:102, June 1928.
- Unsolved Mystery of the Moon. Lit. Dig., 98:5:20, Aug. 4, 1928.
- Do the Stars Rule Our Destiny? Pop. Mech., 49:914, June 1928.
- How Hot is the Moon? Sci. and Inv., 16:124, June 1928.

Crabs
- Crabs and Crablike Curiosities of the Sea. Nat. Geog. Mag., 54:57, July 1928.

City Planning
- Spreading the Gospel of City Plans. Am. City, 2:123, Aug. 1928.
- Regional Plans a Plague. Am. City, 39:1:115, July 1928.
- Forward Steps. Am. City, 39:1:140, July 1928.

Energy
- Super-Rays Reveal Secret of Creation. Pop. Sci. Mo., 113:13, July 1928.

Food
- Do You Know Your Vegetables? Hygeia, 6:322, June 1928.

Forests
- Lowering Cost of Reforesting. Am. City, 39:3:105, Sept. 1928.

Forest Fires
- With the Air Patrol. Pop. Mech., 50:50, July 1928.

Health
- Artificial Respiration by the Prone Pressure Methods. Amer. City, 39:101, July 1928.
- Immunity to Disease. Hygeia, 8:455, Aug. 1928.

Iceland
- A Walking Tour Across Iceland. Natl. Geog. Mag., 53:467, Apr. 1928.

Insects
- Seventeen Year Locusts. Sci. and Inv., 16:305, Aug. 1928.
- Tigers of the Insect World. Pop. Mech., 49:907, June 1928.

Lightning
- Lightning Surges. Jour. of Franklin Inst., 205:747, June 1928.

LOCOMOTIVES
The Iron Horse Snorts Defiance. Pop. Mech., 49:946, June 1928.

MATTER
The Structure of Matter: Hydrogen and Oxygen. Jour. of Chem. Educ., 9:1153, Sept. 1928.
The Nature of Matter. Jour. of Chem. Educt., 9:1135, Sept. 1928.

METALS
New Jobs for Old Metals. Pop. Sci. Mo., 113:3:19, Sept. 1928.

PARKS
Forest River Park and Bath House: Salem. Amer. City, 38:6:100, June, 1928.

PESTS
Controlling Household Pests. Sci. and Inv. 16:16, May 1928.

PHOTOGRAPHY
Why I am a Pictorial Photographer. Photo Era, 61:123, Sept. 1928.
New Magic Worked by Cameras. Pop. Sci. Mo., 113:3:25, Sept. 1928.
Stunts for the Camera. Pop. Mech., 49:1023, June 1928.
Catching Crooks with the Camera. Pop. Sci. Mo., 112:6:36, June 1928.

PLANTS
The Cell, the Building Block of the Plant. Sci. and Inv., 16:318, Aug. 1928.

RADIO
Why the Weather Affects Radio Reception. Radio News, 10:719, Aug. 1928.
Standard Radio Symbols. Radio News, 10:230, Sept. 1928.
The Standardization of Radio Terms and Abbreviations. Radio News, 10:224, Sept. 1928.
When You Buy a Loud Speaker. Pop. Sci. Mo., 113:2:47, Aug. 1928.
Air Craft Radio and Navigation. Jour. of Franklin Inst., 205:849, June 1928.

SCIENCE TEACHING
Science Teacher-Training in North Carolina. High School Jour., 11:213, May 1928.
Archimede's Principle. Science News Letter, 8:269, Apr. 28, 1928.

TEXTILES
The Story of Textiles: Silk. The Home Economist, 6:220, Aug. 1928.

WATER
Water and Its Compounds. Jour. of Chem. Educa., 9:1162, Sept. 1928.

Magazine List

American City. 443 Fourth Ave., New York City. Monthly. $4.00 a year, 50c a copy. The science problems of city and rural communities are treated in numerous articles, well illustrated. A valuable student and teacher reference.

The American Food Journal. 468 Fourth Avenue, New York City. Monthly. $3.00 a year, 25c a copy. Articles on food manufacture, food legislation, and experiments in nutrition.

Commercial America. Philadelphia Commercial Museum, Philadelphia, Pa. $2.00 a year. Ill. Commercial production. New inventions. Will interest commercial geography and science teachers.

The Educational Screen. 5 South Wabash Avenue, Chicago. Monthly. 20c a copy, $1.50 a year; with "1000 and One Films," $1.75 a year. Discusses the use of motion pictures, slides, and other visual aids in our schools; gives brief descriptions of educational films, and lists of theatrical films which are suitable for children. The journal is entirely educational, having no commercial affiliations.

The Home Economist. 468 Fourth Ave., New York City. Monthly. 10c a copy, $1 a year. Gives practical discussions of everyday classroom problems, lesson outlines and plans.

Garden and Home Builder. Garden City, N. Y. Monthly. 35c a copy, $3.00 a year. Ill. Helpful to amateur gardeners, home makers, teachers and pupils.

General Science Quarterly. Salem, Mass. Quarterly. 40c a copy, $1.50 a year. The only journal published devoted alone to science in the elementary and secondary schools. It tells what schools are doing in science, gives lesson plans, demonstrations, and an extensive bibliography of usable articles in current periodicals.

The Guide to Nature. Sound Beach, Conn. Monthly. 15c a copy, $1.50 a year. Ill. Of interest to elementary pupils and teachers of nature study.

Hygeia. 535 North Dearborn St., Chicago. Monthly. 25c a copy, $3.00 a year. Popular articles on individual and community health. A valuable supplement to classroom work in hygiene.

Industrial and Engineering Chemistry. Box 505, Washington, D. C. Monthly. 75c a copy, $7.50 a year. A technical journal which contains much material which teachers can use.

Journal of Chemical Education. 85 Beaver Street, New York City. Monthly. $2.00 a year. Promotes chemical education; primarily a journal for the chemistry teacher. Digests of activities of chemical associations.

Journal of the Franklin Institute. Philadelphia, Pa. Monthly. 50c a copy, $6.00 a year. Ill. A technical journal. Contains many articles of value to science teachers.

Journal of Home Economics. 617 Mills Bldg., 700 17th Street N. W., Washington, D. C. Monthly. 25c a copy, $2.50 a year. For teachers.

The Literary Digest. 354 Fourth Ave., New York. Weekly. 10c a copy, $4.00 a year. Has a department, "Science and Invention." Articles are mostly digests from other journals. They are popular in nature and suitable for high school pupils.

National Geographic Magazine. Washington, D. C. Monthly. 50c a copy, $3.50 a year. Best monthly journal for high-grade pictures. Articles are of interest to general readers, pupils and teachers, as well as to geographers.

The Nation's Health. 370 Seventh Ave., New York, N. Y. Monthly. $3.00 a year, 25c a copy. An illustrated magazine devoted to community, industrial and institutional health problems. Very helpful to the science and hygiene teacher.

Photo-Era Magazine. Wolfeboro, New Hampshire. Monthly. 25c a copy, $2.50 a year. This magazine is for the beginner, the advanced amateur, and the professional photographer. It has much for the science department of universities, schools and summer camps, and will help instructors and pupils to make better photographs.

The Playground. 315 Fowler Avenue, New York City. Monthly. $2 a year, 25c a copy. Illustrated, devoted to outdoor recreation, for home, school and community.

Popular Mechanics Magazine. Chicago. Monthly. 25c a copy, $3.00 a year. Short science items and articles, well illustrated. Appeals strongly to elementary pupils. Suggests many construction problems.

Popular Science Monthly. 225 West 39th Street, New York City. Monthly. $2.50 a year, 25c a copy. A review in text and pictures of the news of science and invention, presented in a humanistic and inspirational way. Used as a supplement to text-books in many high schools. Valuable to science pupils and teachers.

Radio News. 53 Park Place, New York City. 25c a copy, $2.50 per year. Monthly. A practical periodical for all who are interested in radio. Gives radio progress, new hook-ups, and gives much help to one who may wish to construct his own set.

Safety Engineering. 119 Nassau St., New York. Monthly. $3.00 a year, 25c a copy. A journal devoted to conservation of life and property, and contains much material helpful in science classes.

School Science and Mathematics. Chicago. Monthly. $2.50 a year. A teacher's journal. Includes many helpful suggestions.

School Service Bulletin. Issued by Science and Invention, October to June. 20c a year. Gives lesson plans and helps to teachers; also current science topics from Science and Invention and Radio News. It is for students' use in general science classes.

Science Classroom. Issued by "Popular Science Monthly," October to June. 25c a year. A valuable teacher's aid, giving lesson plans, experiments, and many reference suggestions for secondary science teachers.

Scientific American. 24 West 40th St., New York. Monthly. 35c a copy, $4.00 a year. Has longer articles than the other popular science journals. Illustrated. Particularly valuable to high school science pupils and teachers.

Science and Invention. 53 Park Place, New York City. Monthly. 25c per copy, $2.50 a year. Ill. Popular articles on astronomy, physics, photography, radio-activity, medicine, and, in fact, science in general.

Scientific Monthly. Garrison, N. Y. 50c a copy, $5.00 a year. Articles, as a rule, are more along lines of pure science. Much of value to teachers. Articles can be read to advantage by many pupils.

Science News-Letter. Science Service, 1115 Connecticut Ave., Washington, D. C. Weekly. 10c a copy, $5.00 a year. Gives a valuable current summary of the progress of science, in a form usable in science classes.

Transactions of the Illuminating Engineering Society. 29 West 39th Street, New York. Monthly. $1.00 a copy, $7.50 a year. Technical. Many articles contain material which can be used in high school classes.